ASCI White:

The World's Fastest Computer — Meeting the Challenge of Stockpile Stewardship

On August 15, 2001, Lawrence Livermore National Laboratory (LLNL) hosted a dedication ceremony for IBM's *ASCI White*, the world's fastest supercomputer—capable of more than 12 trillion mathematical operations per second.

The United States Department of Energy/National Nuclear Security Administration (NNSA) will use ASCI White to simulate nuclear weapons tests—an essential element of our nation's Stockpile Stewardship effort. Without underground testing, we need computer simulations to make sure our nuclear weapons stockpile is safe, reliable, and operational. ASCI White will compute the factors involved in a nuclear detonation—including a weapon's age and design—and eventually allow the NNSA to manage its entire stockpile of nuclear weapons without any real nuclear tests.

The computational problems that ASCI White will solve for the science-based Stockpile Stewardship Program come from the activities and responsibilities of the three Defense Programs laboratories—LLNL, Los Alamos National Laboratory (LANL), and Sandia National Laboratories (SNL). Advanced computational simulations using ASCI's 3D modeling capability and the latest visualization technologies are vital components of Stockpile Stewardship. Together, these unprecedented achievements in hardware and software technology make possible a much clearer understanding of the issues involved in supporting the U.S. nuclear weapon stockpile and the scientific judgments required to fulfill our Stockpile Stewardship responsibilities.

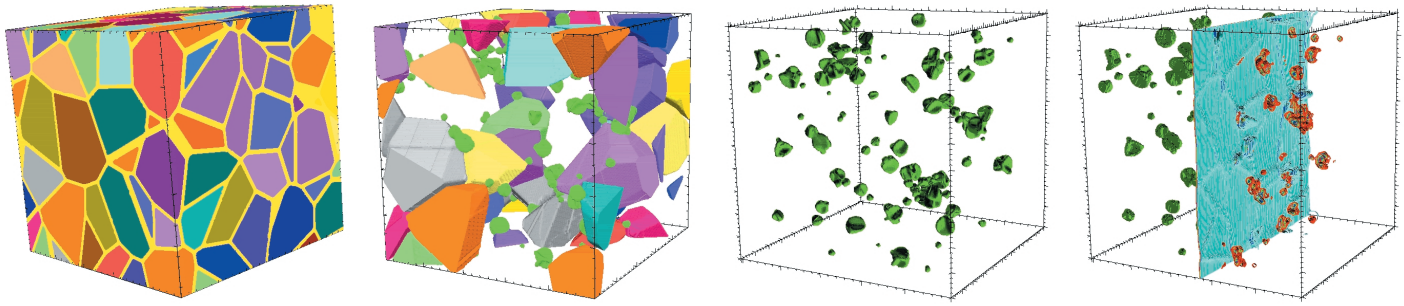
In addition, the capabilities developed through this terascale computing partnership between government and industry will provide a commercial platform for medical simulations, genetic computing, global climate modeling, aerospace and automotive design, financial models, and other domestic applications.

What's Inside

IBM's ASCI White supercomputer is 40,000 times more powerful than the average personal computer. It is able to process more operations in one second than a person with a calculator could do in 10 million years. Its terascale capabilities provide scientists with an essential component to safeguarding the aging nuclear weapons stockpile in the absence of underground testing.

ASCI White covers about 12,000 square feet of floor space—an area greater than that of two NBA basketball courts—and weighs 106 tons. It contains 8,192 microprocessors in 512 shared memory nodes interconnected with high-bandwidth, low-latency interconnect, requiring over 49 miles of cable. Each node contains 16 Power3-II CPUs built with IBM's latest semi-conductor technology (silicon-on-insulator and copper interconnects).

ASCI White has 160 terabytes of storage space in about 7,000 disk drives, approximately 16,000 times the storage capacity of a desktop computer with a 10-GB hard disk. It can hold the equivalent of 300,000,000 books—six times the holdings of the Library of Congress.

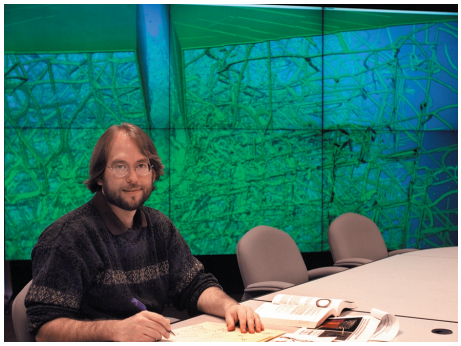


Grain-scale simulations reveal the crucial role of defects in plastic-bonded high explosives. The cube is 100 µm on a side and contains colored grains of HMX and a yellow binder. The second figure shows the cube with the binder and some HMX grains removed. The voids (green) are located between some of the HMX grains. The third figure shows the cube with all the HMX and binder removed, showing only the voids. In the last figure, a shock wave moves through the cube, leaving hot spots (red) where the voids used to be.

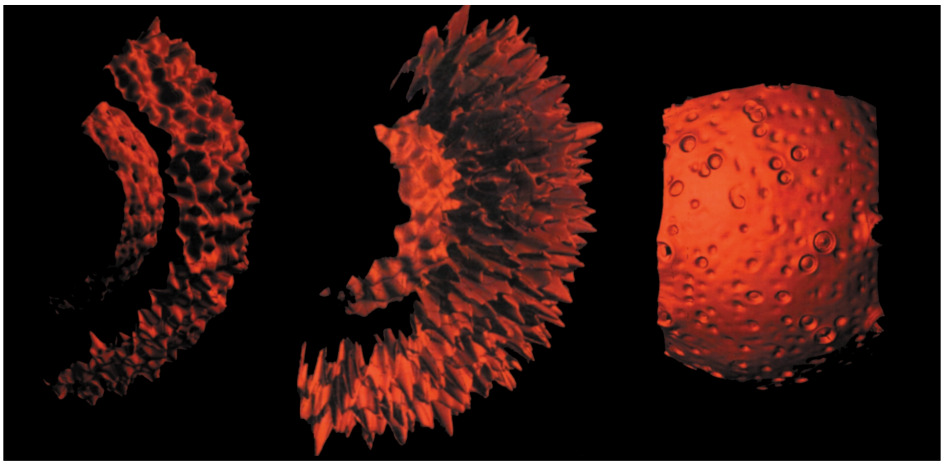
ASCI White: "Doing the Real Work of Stockpile Stewardship"

ASCI White's dedication ceremony was held in its 20,000-ft computer room in Building 451 at LLNL. Guests included scientists and administrators from three Defense Programs national laboratories LLNL, LANL, and SNL, the IBM Corporation, the DOE/NNSA, University of California (UC), and the news media, represented by TV crews, local reporters, CNN, and major wire services.

Speakers acknowledged the system installation and integration efforts between LLNL and its IBM partner, the pursuit and achievement of essential milestones in ASCI's Stockpile Stewardship responsibilities, and the tri-laboratories' utilization of ASCI White's advanced 3D modeling capability and visualization technologies.



ASCI's data visualization display walls, driven by a multiprocessor visualization server, enable scientists to see and understand the complex results of terascale simulations. Interactive applications can be displayed at very high resolution, such as this one-billion-atom molecular dynamics simulation on ASCI White.



ASCI is developing sophisticated 3D computer simulations based on predictive physical models. In a 3D simulation using more than 16 million zones, we studied the growth of hydrodynamic instabilities caused by surface roughness in a target capsule for the National Ignition Facility.

NNSA Administrator General John Gordon asserted that the foundation of science-based Stockpile Stewardship is "to ensure that the nuclear deterrent will continue to be viable in the absence of underground nuclear testing."

Anne Altman, IBM's Managing Director for U.S. Federal Government, called ASCI White "the triumph of vision, perseverance, and plain old-fashioned hard work."

UC Vice President for Laboratory Management John McTague recognized the tri-laboratory ASCI efforts to produce such "spectacular technological achievements."

At the conclusion of the ceremony, LLNL Director Bruce Tarter noted that ASCI White was doing the real work of Stockpile Stewardship, "which is delivering what it was designed to do. This is the place at which you can say the program is a success," Tarter concluded.

For the construction history and more information about ASCI White, please visit our websites at http://www.llnl.gov/asci/platforms/white/index.html and http://www.llnl.gov/asci/news/white_news.html

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